Inter-comparison between AIRS and IASI through retrieved parameters

Daniel K. Zhou[1], Xu Liu[1], Allen M. Larar[1], William L. Smith[2], Jonathan P. Talor[3], Peter Schlüseel[4], L. Larrabee Strow[5], and Steve Mango[6]

[1]NASA Langley Research Center, Hampton, VA, USA; [2]Hampton University, Hampton, VA, USA; [3]Met Office, Exeter, Devon, UK; [4]EUMETSAT, Darmstadt, Germany; [5]University of Maryland Baltimore County, Baltimore, MD, USA; [6]Intergrated Program Office, Silver Spring, MD, USA

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Atmospheric InfraRed Sounder (AIAS) instrument (by NASA) on Aqua Satellite launched on 4 May 2002

4 May, 2002

Infrared Atmospheric Sounding Interferometer (IASI) instrument (by CNES / EUMETSAT) on MetOp-A Satellite launched on 19 October 2006

19 Oct., 2006

ABSTRACT

Ultra-spectral resolution infrared spectral radiance obtained with current on orbit instruments such as the Atmospheric InfraRed Sounder (AIRS) and the Infrared Atmospheric Sounding Interferometer (IASI). These observations provide atmospheric, surface, and cloud property information. An advanced retrieval algorithm with a fast radiative transfer model, including cloud effects, is used for atmospheric profile and cloud parameter retrieval. A one-dimensional (1-d) variational multi-variable inversion solution is used to improve an iterative background state defined by an eigenvector-regression-retrieval. This physical inversion scheme has been developed, dealing with cloudy as well as cloud-free radiance observed with ultra-spectral infrared sounders, to simultaneously retrieve surface, atmospheric thermodynamic, and cloud microphysical parameters. Retrievals of atmospheric soundings, surface properties, and cloud optical/microphysical properties with AIRS and IASI observations are obtained and presented. These retrievals are further inter-compared with those obtained from airborne FTS system, such as the NPOESS Airborne Sounder Testbed – Interferometer (NAST-I), dedicated dropsondes, radiosondes, and ground based Raman Lidar. The capabilities, in terms of measurement and/or calibration accuracies, of current satellite ultra-spectral sounders such as the AIRS and IASI are investigated through their retrieval parameters
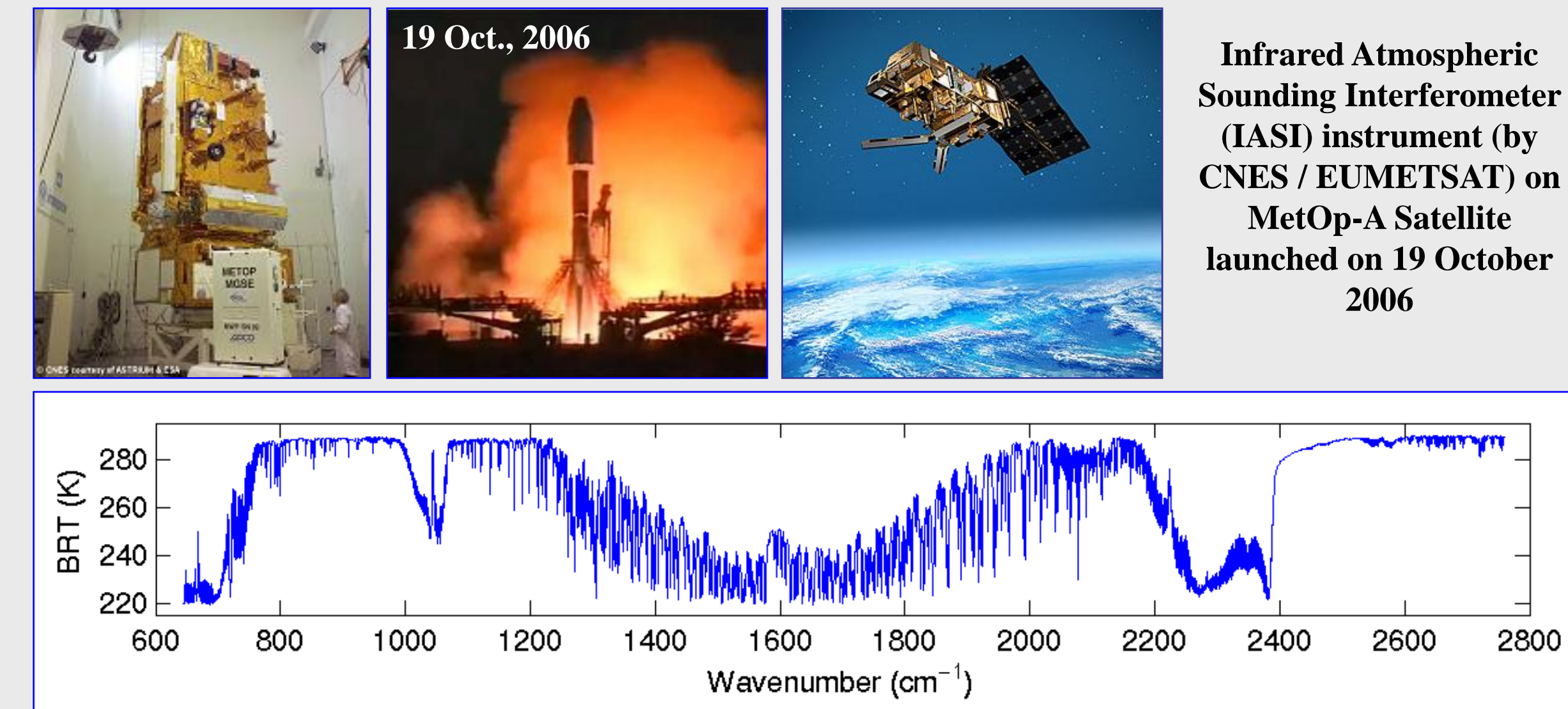
RETRIEVAL METHODOLOGY

PART A: REGRESSION RETRIEVAL

Diagnose 0-2 cloud layers from radiosonde relative humidity profile:
A single cloud layer is inserted into the input radiosonde profile. Approximate lower level cloud using opaque cloud representation.

Use parameterization of balloon and aircraft cloud microphysical data base to specify cloud effective particle diameter and cloud optical depth:
Different cloud microphysical properties are simulated for same radiosonde using random number generator to specify visible cloud optical depth within a reasonable range. Different habitats can be specified (Hexagonal columns assumed here).

Use LBLRTM/DISORT "lookup table" to specify cloud radiative properties:
Spectral transmittance and reflectance for ice and liquid clouds interpolated from multi-dimensional look-up table based on DISORT multiple scattering calculations.

Compute EOFs and Regressions from cloudy radiance data base:
Regress cloud properties, surface & atmospheric profile parameters against radiance EOFs.

PART B: 1-D VAR PHYSICAL RETRIEVAL

A one dimensional (1-d) variational solution, also known as the regularization algorithm or the minimum information method, is chosen for physical retrieval methodology which uses the regression solution as the initial guess.

Cloud microphysical parameters, namely effective particle diameter and visible optical thickness, are further refined with the radiances observed within the 10.4 μm to 12.5 μm window region.

JOINT AIRBORNE IASI VALIDATION EXP. (JAIVEx)

EUMETSAT Metop

NASA Aqua
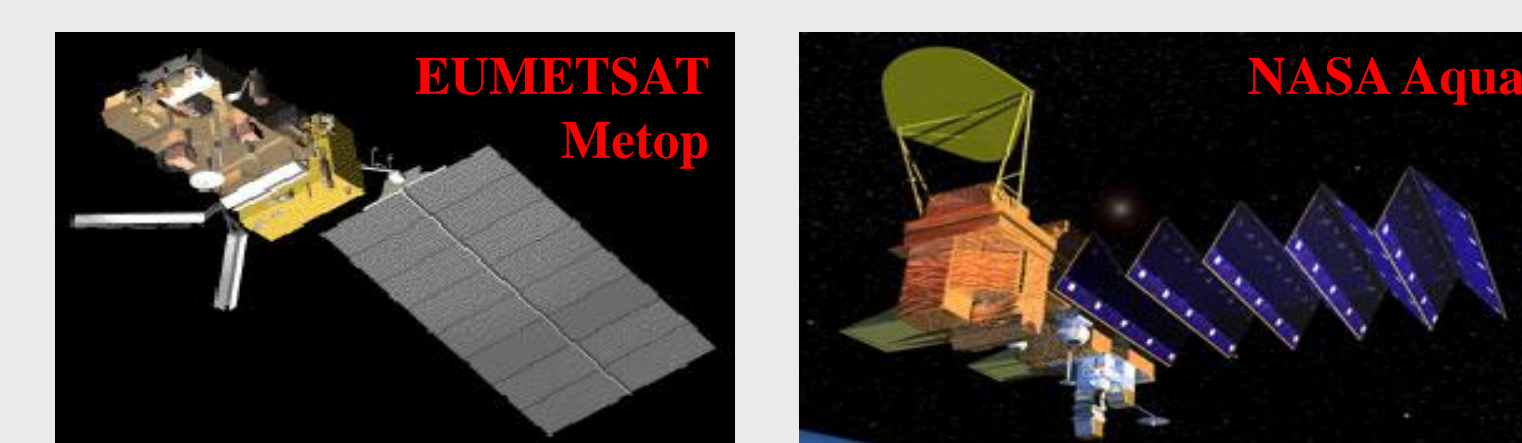
Location/dates:
Ellington Field (EFD), Houston, TX, 14 Apr – 4 May, 2007.

Aircraft:
NASA WB-57 (NAST-I, NAST-M, S-HIS); UK FAAM BAe146-301 (ARIES, MARSS, SWS; dropsondes; in-situ cloud phys. & trace species; etc.).

Satellites:
Metop (IASI, AMSU, MHS, AVHRR, HIRS). A-train (Aqua AIRS, AMSU, HSB, MODIS; Aura TES; CloudSat; and Calipso).

Ground-sites:
DOE ARM CART ground site (radiosondes, lidar, etc.)

Participants:
include NASA, UW, MIT, IPO, NOAA, UKMO, EUMETSAT, ECMWF, …

NASA WB-57

UK FAAM BAe 146-300

HIGH-VERTICALLY-RESOLVED RETRIEVALS FROM IASI
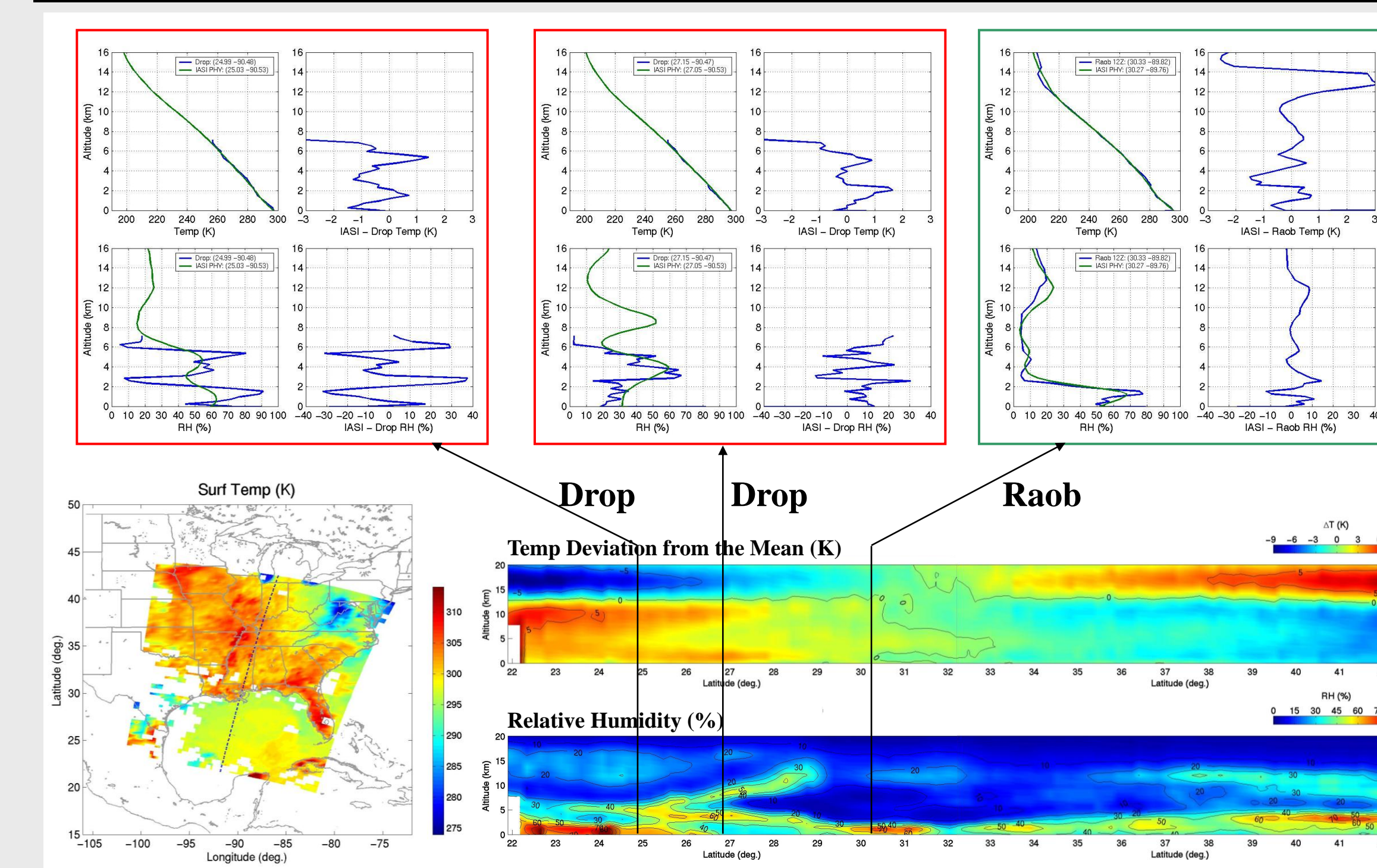

Drop   Drop   Raob

Figure 1. IASI retrievals validated with coincident dropsondes and radiosonde. The vertical cross section is located on the dash-line plotted on the image of surface skin temperature.

IASI (15:48 UTC) VS. AIRS (19:30 UTC)

IASI Retrieval
Temp Deviation from the Mean (K)
Relative Humidity (%)

AIRS Retrieval Interpolated to IASI FOV
Temp Deviation from the Mean (K)
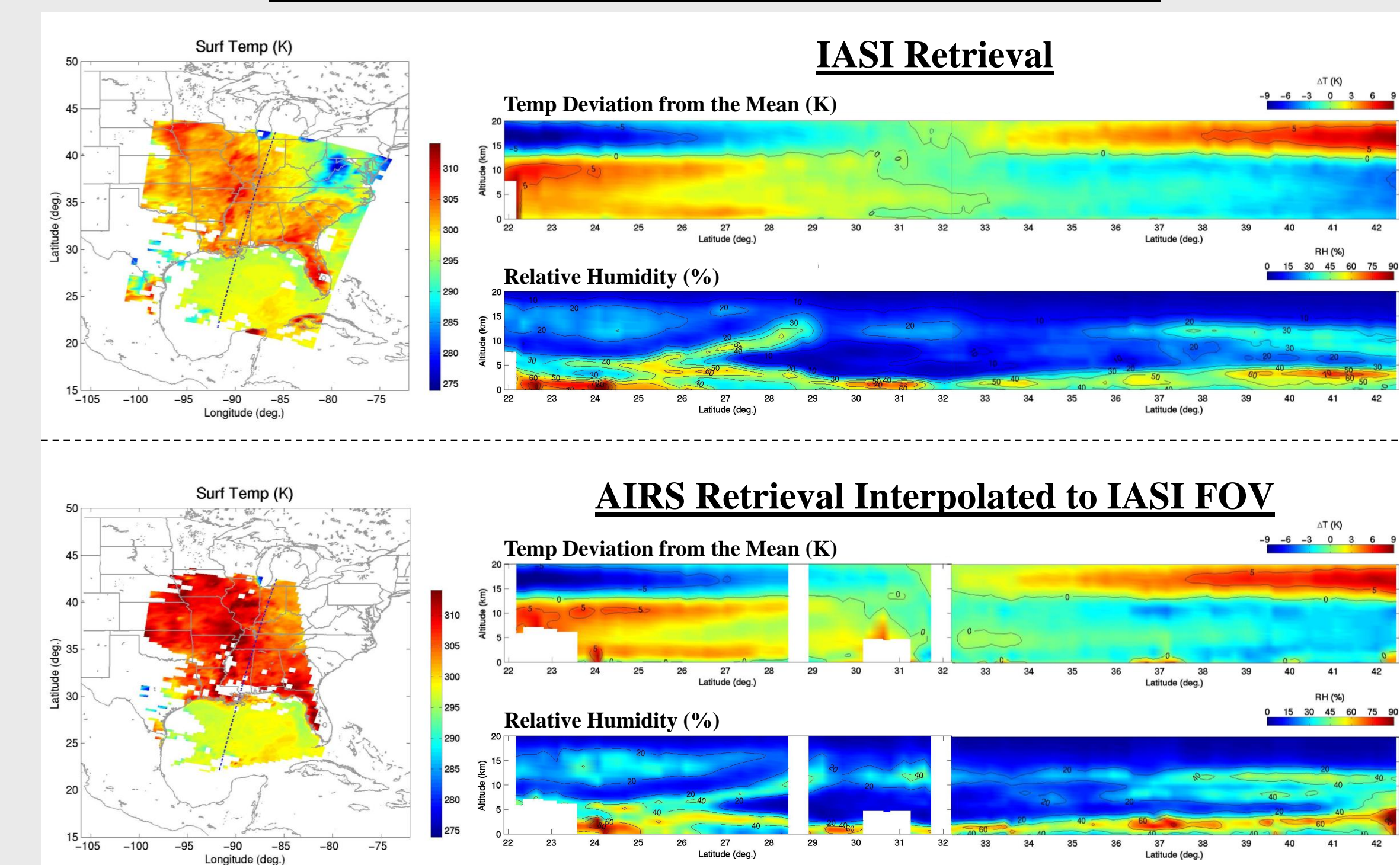Relative Humidity (%)

Figure 2. AIRS retrievals are interpolated IASI FOV for inter-comparison, the cross sections of AIRS and IASI are from the same geophysical location.

NAST-I: CONNECTION BETWEEN IASI AND AIRS

IASI @ ~15:48 UTC

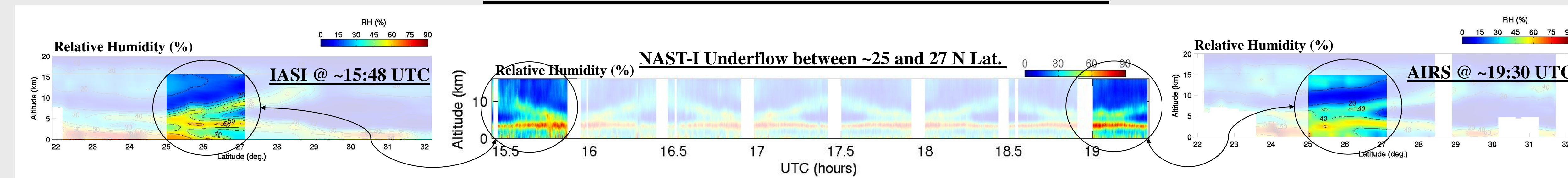NAST-I Underflow between ~25 and 27 N Lat.

AIRS @ ~19:30 UTC

Figure 3. IASI and AIRS temporal variation is verified with NAST-I (with 2 km horizontal resolution). Subtle field evolution characteristics (from IASI to AIRS) are confirmed by NAST-I.

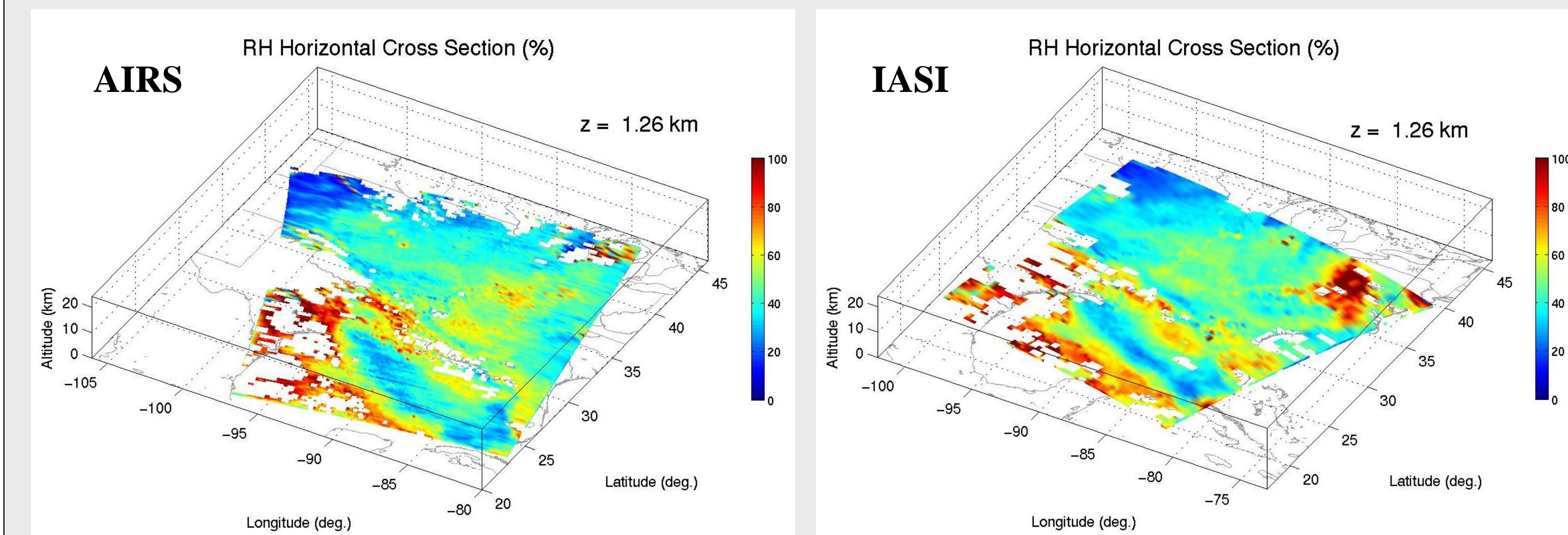## IASI VS. AIRS: TBL MOISTURE (i.e., RH)

AIRS   IASI

RH Horizontal Cross Section (%)

z = 1.26 km

Figure 4. Horizontal moisture field from AIRS and IASI

IASI VS. AIRS: Surface Emissivity @ 12 μm

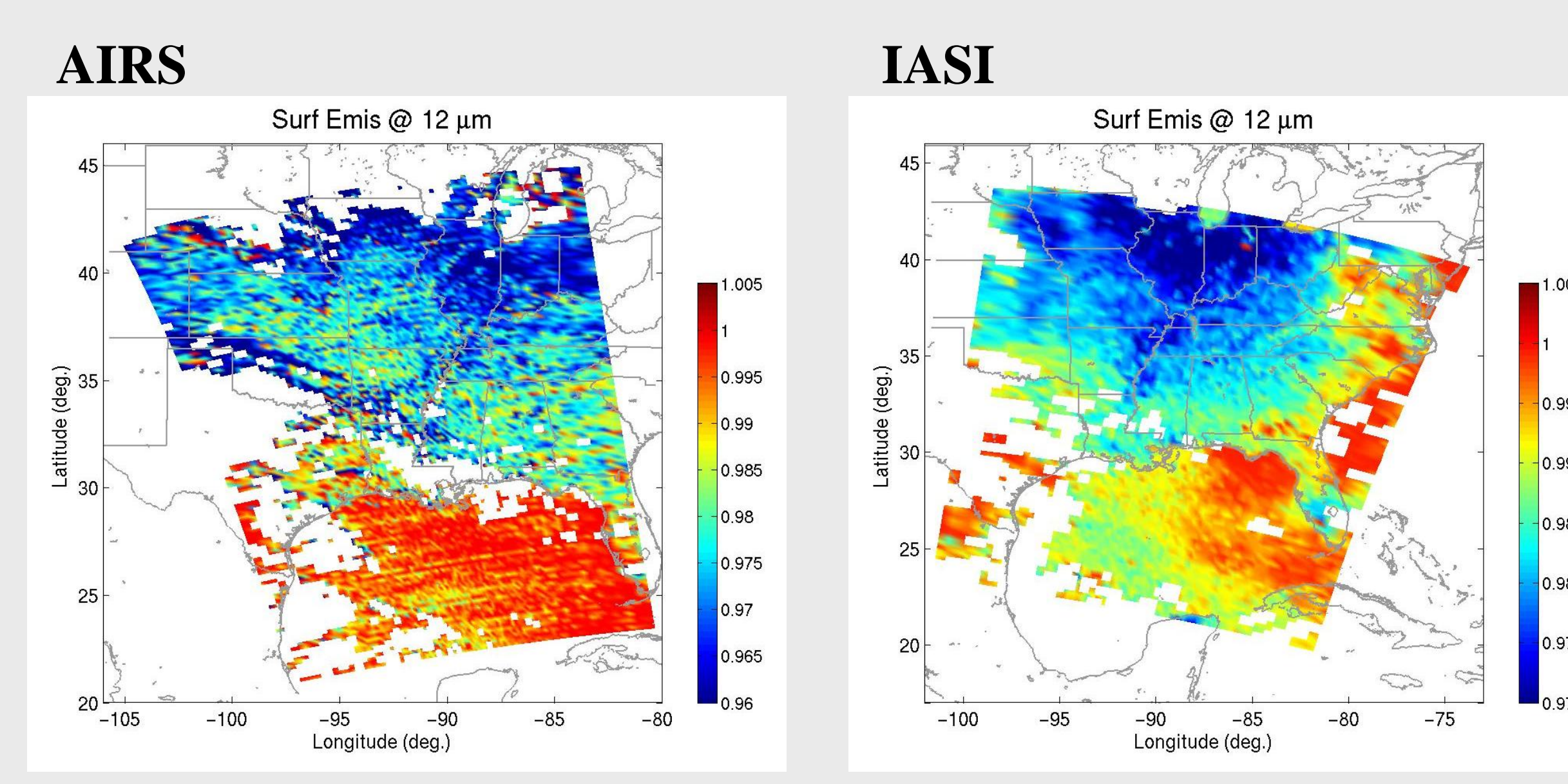AIRS   IASI

Surf Emis @ 12 μm

Figure 5. Emissivity field from AIRS and IASI.

SUMMARY

A State-of-the-art retrieval algorithm dealing with all-weather conditions has been applied to satellite/aircraft instruments retrieving cloud/surface and atmospheric conditions. High quality retrievals have been achieved from IASI data. Surface, cloud, and atmospheric structure and variation are well captured by IASI measurements and/or retrievals. The same retrieval algorithm is also applied to AIRS for retrieval inter-comparison. Both AIRS and IASI have a similar FOV size but AIRS has a higher horizontal resolution. AIRS data can be interpolated to IASI horizontal resolution for inter-comparison at the same geophysical locations, however a temporal variation between AIRS and IASI observations need to be considered. JAIVEx has employed aircraft to obtain the atmospheric variation filling the temporal gap between two satellites. First results show that both AIRS and IASI have a very similar vertical resolving power, atmospheric conditions are well captured by both instruments, and radiances are well calibrated. AIRS data shown in retrievals (e.g., surface emissivity and moisture) have a relatively higher noise level. Since the this type of retrieval is very sensitive to its radiance quality, retrieval products inter-comparison is an effective way to identify/compare their radiance quality, in terms of a combination of spectral resolution and noise level, and to assess instrument performance. Additional validation analyses are needed to provide more-definitive conclusions.